Z-Axis Source Deployment Procedures
with the New KamLAND Full-Volume Calibration System

March 4, 2005 -- Version 1.5
Edited by B. Berger, F. Gray, K. Heeger, H. Steiner

Note: This procedure is to be used as a check-list. Please mark every step once it has been completed. At the end, please file this check list and your comments in the calibration folder.

Date:
Calibration Expert:
Type of Source:

Section I: Standard Procedure for Z-Axis Calibrations
See Section II for recovery procedures during unusual occurrences. This procedure assumes that the source deployment has already been prepared as described in parts I, II, and III(a) of E. Yakushev, "Short manual for deployment of calibration sources into KamLAND."

(1) ❑ Turn on general power of 4pi electronics rack in HV clean room, and power on drives for motors 1 and 2. (Motor 2 will disabled in software.)

(2) ❑ Press the reset button on the manual control panel next to the glovebox.
(Note: Besides the reset and stop buttons, the manual control panel is never to be used in the regular z-axis calibration with the system. However, it is powered on and connected to the drives at all times during calibrations!)

(3) ❑ Inspect the system and verify that the source and z-axis weight are connected to the upper cable.

(4) ❑ Using the laptop in the calibration tent connect to the calibration control computer in the HV clean room via VNC. (Details to be included).

(5) ❑ Open the folder marked "z-axis".
- Click on *1-rmiregistry*. It will open a terminal screen with no output.
- Click on *2-control*. It will open a terminal screen with debugging output scrolling.
- Click on *3-display*. It opens a window with the user interface for the z-axis mode.

(6) ❑ Check the expert parameter settings. The default settings are:

Source offset:	varies for each source: ???? for ^{60}Co ???? for composite source ???? for Hg
Absolute to detector:	???? cm
Motor torque limit:	0.4 Nm
Motor pulley encoder tolerance:	10.0 cm

Velocity:	5 motor rev/s
Acceleration:	1 motor rev/s^2
Fraction to target per step:	0.8
Tolerance to end step:	100 motor counts
Limit switch position:	-97.2 cm

If you find different parameters in the expert dialog, please contact a 4pi or calibration expert!

(7) ❑ Perform taring procedure: Press "Tare" on the main screen; this action will open a new dialog window. Press "Tare" in the dialog box. The system will now move into its home position until it activates the limit switch. This position is used to tare the system before every calibration. Once the motion is complete and the system is in its home position verify that the source position reads -97.2 cm.

(8) ❑ Move the system to -50cm: Type "-50" in the text field for Target and press Enter. Double-check that the text field reads back "-50.00," then press "Go". The system will move to this position, which is comfortable for changing the source using the lower set of glove ports.

(9) ❑ Perform the taring procedure again, as described in step (7). By approaching the limit switch at a consistent speed (always starting at -50 cm), variation in the tare point is minimized.

(10) ❑ Remove the cover plate from the 6" opening at the bottom of the glovebox.

(11) ❑ Move system, down to +40cm. Type "40" in the text field for target and press Enter. Double-check that the text field reads back "40.00," and press "Go". This will move the source and cable coupling parts right below the 6" flange opening.

(12) ❑ Place the z-axis cover plates over the 6" hole: First, slide the lower plate onto the cable and set it down on the flange. Then, place the second plate over it at 180 degrees to cover the slit opening of the lower plate.

(13) ❑ Start supply of nitrogen into M5C region with as low a flow rate as possible (less than 1 L/minute). The pressure in the glovebox should be less than 1 inch H_2O.

(14) ❑ Switch off light in glovebox, place the cover plate and light shield over the glovebox windows, and switch off the light in the calibration tent.

(15) ❑ Attach the glovebox glove protectors. Apply only 1-2 turns on the bolts, in order to use the gloves as a buffer in case of an unexpectedly high pressure difference between the glovebox and the chimney.

(16) ❑ Double-check that the preceding steps have been completed properly. Verify that the 6" gate valve is open and that the red "6 inch GV Open" label is on the whiteboard. The M5C and GB are purged overnight so the 6" gate valve is usually opened the day before a deployment.

(17) ❑ Connect the M5C region to the chimney by opening the V8 valve on the lower gas panel to equalize the pressure.

(18) ❑ Open the 16" gate valve: switch motor power on, unlock red button, push "open" button, wait for indication that the gate valve is opened, and lock the red button. Check the "open" indication a few times by turning the power on and off. Then turn the power off and remove the key. Put the red "16 inch GV Open" label on the whiteboard.

(19) ❑ Close the V8 valve that was opened in step (17).

(20) ❑ Move the calibration source to its target position.
(Note: The control program accepts inputs for the absolute position of the reference pins on the pole attachment segment, and translates the current position into a source position in both absolute and detector coordinates.)

(21) ❑ Perform source calibrations runs. Repeat steps 14 and 15 if necessary.

(22) ❑ Move system back to +40cm. Type "40" in the text field for target and press Enter. Double-check the target position before pressing "Go." This will move the source and cable coupling parts right below the 6" flange opening.

(23) ❑ Using the IR camera verify that the special mark on the cable is visible. This ensures that the source is above the 16" gate valve, and it can be closed safely.

(24) ❑ Close the 16" gate valve, reversing the instructions in step 18.

(25) ❑Turn off nitrogen supply to M5C region that was started in step (13). Check the O_2 level in the glovebox, then return the gas system to its original condition.

(26) ❑ Remove cover plates from 6" flange opening.

(27) ❑ Recheck that the source is still clear of the gate valves (at this point the light cover may be removed and the position verified by eye), then close the 6" gate valve and remove its tag from the whiteboard.

(28) ❑ Perform "Tare" procedure to move the system back into its home position. Press "tare" and wait for the Tare dialog box to open. Press "tare" again in dialog box. The system is now moving upwards towards the limit switch.

(29) ❑ Cover opening of 6" flange with cover plate.

(30) ❑ Quit control program:
Close the display window by clicking the close box in the upper right corner.
Go to terminal window for *1-control*: Press "Control-C" twice.
Go to terminal window for *2-rmiregistry*: Press "Control-C" once.
Quit VNC, and switch off computer.

(31) ❑ Press "Stop" on the manual control panel.

(32) ❑ Switch off the 4pi electronics racks in the HV clean booth.

(33) ❑ Take a background run (same settings as ^{203}Hg), then start a normal run. Notify the shift crew that the calibration is finished.

(34) ❑ As Evgueni suggested at the conclusion of his procedure, “drink bear.” (Sometimes even typos can be brilliant.)

Section II. Unusual Occurrences

As a general rule, any unusual occurrence will require that the system be returned to its tare position to re-establish a calibration. Such events will include:

- Power interruption
- Motor or encoder failure
- Control program crash
- Tripping the limit switch while the system is away from its home position

1. Diagnose and fix any underlying problem: if power was lost, ensure that it is reconnected, all of the hardware is on, and the system is enabled (press the reset button on the manual control panel if necessary). If the software is not running, then restart it.
2. Clear any messages in the "immediate stop" panel in the display program.
3. If the system was in upward motion and the limit switch was accidentally tripped, it will be necessary to make a small step down before upward motion will be allowed by the motor controller. Type a position that is a few mm larger than the currently displayed encoder coordinate, press Enter, double-check that your input was accepted, and press "Go."
4. Attempt to determine the current position from the the pressure transducer reading and from the last-known encoder reading in the log file.
5. If you are able to determine with some confidence the current position (for example, if the pressure sensor and the log file agree within a few cm), then press the "Recovery..." button, enter this known position, and press "Tare." This will reset the encoder reading and the motor calibration based on the information that you provide. Go to step (22) in the standard procedure to re-tare, then restart the calibration if desired.
6. On the other hand, if for some reason you do not know and cannot determine the current position, it may be necessary to tare the system "blind." Turn off the detector HV so that you can see what is happening. Remove the cover plates and wait for any swinging of the cable to damp out. Then press the "Tare..." button in the control program and the "Tare" button in the display program.

Appendix

Definition of the Zero Position of the System

The zero point for the encoder reading is the position the system would be in if the lower pins on the source attachment coupling were resting in the 4pi pivot block. (The pivot block is not used in z-axis mode, but this definition allows a consistent coordinate system for 4pi and z-axis modes.) In this system, the positive direction is downwards.

The control software translates these encoder readings into an absolute source position and the source position in detector coordinates. The same zero reference is used during the z-axis use of the new deployment system even though the pin block is not used during z-axis calibrations.

Definition of Expert Parameter Settings

Source offset: (cm)
Distance between the center of the source activity and the lower pin of the cable coupling.

Absolute to detector coordinates
Distance between the lower pin block and the center of the detector.

Motor torque limit: (Nm)
This is an empirical parameter defined in tests of the system and set sufficiently low to protect against damage if the cable is stalled.

Motor pulley encoder tolerance: (cm)
The control software checks the reading between the motor encoders and the pulley encoders. The tolerance defines the maximum allowed difference in these readings.

Velocity: (motor rev/s)
Speed of the system during motion.

Acceleration: (motor rev /s^2)
Acceleration of the system during the start and end phase of a motion step.

Fraction to target per step:
Fraction of step the system takes before it re-evaluates its position.

Tolerance to end step: (motor counts)
Defines how closely encoder and target must agree before position feedback stops.

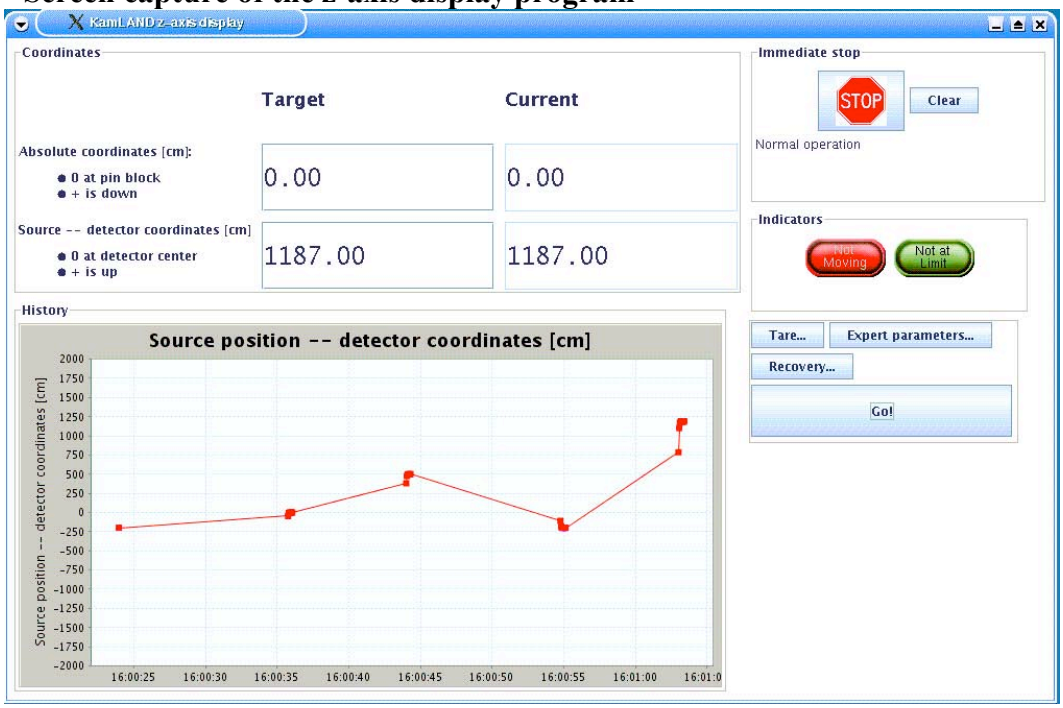
Limit switch position:
The position the system is in when the source attachment coupling trips the limit switch. (It is not the distance between the pin block and the limit switch – it is a distance between system positions.)

Photographs of Hardware

Manual Control Panel

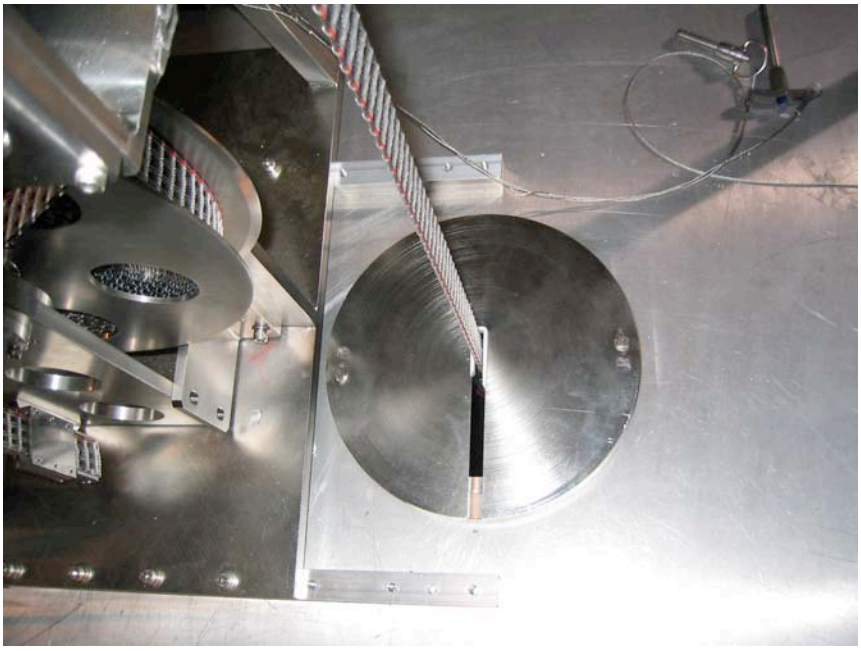
During the z-axis calibration only the reset button and the emergency stop button on the right-hand panel should be used, not the manual control buttons:

Screen capture of the z-axis display program



Z-Axis Cover Plates

Step 1: Slide lower cover plate over cable and set it down onto flange.



Step 2: Slide second cover plate over cable from the opposite site so that the open slit is covered.